CB-22 EXAMPLE CALCULATION

Part I: Calculation of tunnel effluent concentrations

- Duration of testing:

CB-22A	= 20 min	CB-22D	= 22 min
CB-22B	= 21 min	CB-22E	= 21 min
CB-22C	= 21 min	CB-22F	= 21 min
	CB-22 = 126 min		

- Blank-corrected backup filter net weight:
  Tare weight = 2779.8 mg
  Final weight = 2851.0 mg
  Blank correction = -1.37 mg
  Filter net weight = 72.57 mg
  *Net weight constitutes PM-10 mass collected by effluent sampler

- Cyclone flow rate = 40 cfm = 1.13267 m^3/min

Average effluent PM-10 concentration:

$$\frac{72.57 \text{ mg}}{1.13267 \text{ m}^3/\text{min} \times 126 \text{ min}} = 0.508 \text{ mg/m}^3$$

- Blank-corrected background filter net weight:
  Tare weight = 2740.7 mg
  Final weight = 2756.5 mg
  Blank correction = -1.37 mg
  Filter net weight = 17.17 mg
  *Half of net weight assumed to be PM-10 mass collected from ambient air
  PM-10 mass collected = 8.585 mg

- Duration of background sampling = 289 min
- Cyclone flow rate = 40 cfm = 1.13267 m^3/min

Background PM-10 concentration:

$$\frac{8.585 \text{ mg}}{1.13267 \text{ m}^3/\text{min} \times 289 \text{ min}} = 0.026 \text{ mg/m}^3$$

Net PM-10 concentration (attributable to emissions from test area):

$$0.508 \text{ mg/m}^3 - 0.026 \text{ mg/m}^3 = 0.482 \text{ mg/m}^3$$

- Cyclone catch:
  Bag tare weight = 3.6340 g
  Bag final weight = 3.6766 g
  Bag net weight = 0.0426 g = 42.6 mg
  *Sample collected in bag represents suspended particles greater than 10 μm aerodynamic diameter

Average effluent TSP concentration:

$$\frac{72.57 \text{ mg} + 42.6 \text{ mg}}{1.13267 \text{ m}^3/\text{min} \times 126 \text{ min}} = 0.807 \text{ mg/m}^3$$

1/4

Calculation of erosion potentials

- Average maximum Δp at tunnel centerline (CL) during test runs:
  CB-22A = 0.33 in. H_2O
  CB-22B = 0.36 in. H_2O
  CB-22C = 0.27 in. H_2O
  CB-22D = 0.25 in. H_2O
  CB-22E = 0.25 in. H_2O
  CB-22F = 0.23 in. H_2O
  CB-22 = 0.28 in. H_2O

- Factor conversion of Δp to wind speed (mph):
  Average barometric pressure = 24.8 in. Hg
  Ambient temperature = 84°F

$$K' = 10.83 \times \left(\frac{(84°F + 459.3)}{24.8 \text{ in. Hg}} \right)^{1/2} = 50.69$$

Maximum wind speed (mph) at tunnel CL:

$$50.69 \times (0.28 \text{ in. } H_2O)^{1/2} = 26.8 \text{ mph}$$

- Surface roughness height for test period = 1.21 cm

- Tunnel CL height = 7.62 cm

Equivalent maximum wind speed (mph) at 10-m height:

$$\frac{26.8 \text{ mph} \times \ln \frac{1000 \text{ cm}}{1.21 \text{ cm}}}{\ln \frac{7.62 \text{ cm}}{1.21 \text{ cm}}} = 97.8 \text{ mph}$$

Corresponding friction velocity:

$$\frac{26.8 \text{ mph} \times 0.4}{\ln \frac{7.62 \text{ cm}}{1.21 \text{ cm}}} = 5.83 \text{ mph} = 260.6 \text{ cm/s}$$

- Net PM-10 mass collected:

$$72.57 \text{ mg} - \left(8.585 \text{ mg} \times \frac{126 \text{ min}}{289 \text{ min}}\right) = 68.83 \text{ mg} = 0.06883 \text{ g}$$

*Background mass time-weighted to emission sampler run time

- Ratio of sampling extension area to intake nozzle area:
  Sampling extension i.d. = 7.874 in Sampling extension area = 48.69 in^2
  Intake nozzle i.d. = 0.88 in Intake nozzle area = 0.608 in^2
  Ratio = 80.08

- Exposed test surface area dimensions = 4 ft x 6 in
- Area of ground surface sampled = 2 ft^2 = 0.1858 m^2

PM-10 erosion potential/loss:

$$\frac{0.06883\ g \times (80.08 \times 85\%)}{6 \times 0.1858\ m^2} = 4.20\ g/m^2$$

*Six test areas sampled during CB-22
*85% of the centerline wind speed is the average wind speed over the area of the sampling extension

TSP erosion potential/loss:

$$\frac{(0.06883\ g + 0.0426\ g) \times (80.08 \times 85\%)}{6 \times 0.1858\ m^2} = 6.80\ g/m^2$$

*Six test areas sampled during CB-22
*85% of the centerline wind speed is the average wind speed over the area of the sampling extension

Part II: Calculation of tunnel effluent Pu239 activity levels and concentrations

- Duration of testing = 126 min
- Blank-corrected tunnel effluent PM-10 mass = 72.57 mg
- Duration of background sampling = 289 min
- Blank-corrected tunnel inlet PM-10 mass = 8.585 mg
- Time-weighted blank-corrected tunnel inlet (background) PM-10 mass:

$$8.585 \text{ mg} \times \frac{126 \text{ min}}{289 \text{ min}} = 3.74 \text{ mg}$$

Net tunnel effluent PM-10 mass:

$$72.57 \text{ mg} - 3.74 \text{ mg} = 68.83 \text{ mg}$$

- Volume of air sampled by emission sampler:
  40 cfm x 126 min = 5040 ft^3 = 142.7 m^3
- Volume of air sampled by background sampler:
  40 cfm x 289 min = 11560 ft^3 = 327.3 m^3

Net PM-10 concentration:

$$\frac{68.83 \text{ mg}}{142.7 \text{ m}^3} = 0.482 \text{ mg/m}^3$$

- Tunnel effluent Pu239 activity = 0.174 dpm
- Tunnel inlet Pu239 activity = 0.004 dpm

Tunnel effluent Pu239 concentration:

$$\frac{0.174 \text{ dpm/filter} \times 0.45 \text{ pCi/dpm}}{142.7 \text{ m}^3\text{/filter}} = 0.00055 \text{ pCi/m}^3$$

Tunnel inlet Pu239 concentration:

$$\frac{0.004 \text{ dpm/filter} \times 0.45 \text{ pCi/dpm}}{327.3 \text{ m}^3\text{/filter}} = 0.0000055 \text{ pCi/m}^3$$

Pu239 concentration attributed to PM-10 eroded from soil:

$$0.00055 \text{ pCi/m}^3 - 0.0000055 \text{ pCi/m}^3 = 0.0005445 \text{ pCi/m}^3$$

- Tunnel effluent >PM-10 mass = 42.6 mg
- Tunnel effluent TSP mass:
  42.6 mg + 72.57 mg = 115.17 mg
- Blank-corrected tunnel inlet TSP mass = 17.17 mg
- Time-weighted blank-corrected tunnel inlet TSP mass:

$$17.17 \text{ mg} \times \frac{126 \text{ min}}{289 \text{ min}} = 7.49 \text{ mg}$$

Net tunnel effluent TSP mass:

$$115.17 \text{ mg} - 7.49 \text{ mg} = 107.68 \text{ mg}$$

- Volume of air sampled by emission sampler:
  40 cfm x 126 min = 5040 ft^3 = 142.7 m^3
- Volume of air sampled by background sampler:
  40 cfm x 289 min = 11560 ft^3 = 327.3 m^3

Net TSP concentration:

$$\frac{107.68 \text{ mg}}{142.7 \text{ m}^3} = 0.755 \text{ mg/m}^3$$

- Tunnel effluent PM-10 Pu239 activity = 0.174 dpm
- Tunnel effluent >PM-10 Pu239 activity = 1.200 pCi/g = 0.0012 pCi/mg
- Tunnel inlet TSP Pu239 activity = 0.004 dpm

Tunnel effluent >PM-10 concentration:

$$\frac{42.6 \text{ mg}}{142.7 \text{ m}^3} = 0.299 \text{ mg/m}^3$$

Tunnel effluent >PM-10 Pu239 concentration:

$$0.0012 \text{ pCi/mg} \times 0.299 \text{ mg/m}^3 = 0.00036 \text{ pCi/m}^3$$

Tunnel effluent TSP Pu239 concentration:

$$0.00036 \text{ pCi/m}^3 + 0.00055 \text{ pCi/m}^3 = 0.00091 \text{ pCi/m}^3$$

Tunnel inlet TSP Pu239 concentration:

$$\frac{0.004 \text{ dpm/filter} \times 0.45 \text{ pCi/dpm}}{327.3 \text{ m}^3\text{/filter}} = 0.0000055 \text{ pCi/m}^3$$

Pu239 concentration attributed to TSP eroded from soil:

$$0.00091 \text{ pCi/m}^3 - 0.0000055 \text{ pCi/m}^3 = 0.0009045 \text{ pCi/m}^3$$

Alternative Calculation

- Duration of testing = 126 min
- Blank-corrected tunnel effluent PM-10 mass = 72.57 mg = 0.07257 g
- Duration of background sampling = 289 min
- Blank-corrected tunnel inlet TSP mass = 17.17 mg
- Blank-corrected tunnel inlet PM-10 mass = 8.585 mg
- Time-weighted blank-corrected tunnel inlet (background) PM-10 mass:

$$8.585 \text{ mg} \times \frac{126 \text{ min}}{289 \text{ min}} = 3.74 \text{ mg} = 0.00374 \text{ g}$$

Net tunnel effluent PM-10 mass:

$$72.57 \text{ mg} - 3.74 \text{ mg} = 68.83 \text{ mg} = 0.06883 \text{ g}$$

- Volume of air sampled by emission sampler:
  40 cfm x 126 min = 5040 ft^3 = 142.7 m^3
- Volume of air sampled by background sampler:
  40 cfm x 289 min = 11560 ft^3 = 327.3 m^3

Net PM-10 emission concentration:

$$\frac{68.83 \text{ mg}}{142.7 \text{ m}^3} = 0.482 \text{ mg/m}^3 = 0.000482 \text{ g/m}^3$$

- Tunnel effluent Pu239 activity = 0.174 dpm
- Tunnel inlet Pu239 activity = 0.004 dpm

Tunnel effluent Pu239 activity:

$$\frac{0.174 \text{ dpm} \times 0.45 \text{ pCi/dpm}}{0.07257 \text{ g}} = 1.08 \text{ pCi/g}$$

$$1.08 \text{ pCi/g} \times 0.07257 \text{ g} = 0.078 \text{ pCi}$$

Tunnel inlet Pu239 activity:

$$\frac{0.004 \text{ dpm/filter} \times 0.45 \text{ pCi/dpm}}{0.01717 \text{ g}} = 0.10 \text{ pCi/g}$$

$$0.10 \text{ pCi/g} \times 0.00374 \text{ g} = 0.000374 \text{ pCi}$$

Net Pu239 activity:

$$0.078 \text{ pCi} - 0.000374 \text{ pCi} = 0.0776 \text{ pCi}$$

$$\frac{0.0776 \text{ pCi}}{0.06883 \text{ g}} = 1.13 \text{ pCi/g}$$

Pu239 concentration attributed to PM-10 eroded from soil:

$$1.13 \text{ pCi/g} \times 0.000482 \text{ g/m}^3 = 0.00055 \text{ pCi/m}^3$$

- Tunnel effluent >PM-10 mass = 42.6 mg = 0.0426 g
- Tunnel effluent TSP mass:
  42.6 mg + 72.57 mg = 115.17 mg
- Blank-corrected tunnel inlet TSP mass = 17.17 mg = 0.01717 g
- Time-weighted blank-corrected tunnel inlet TSP mass:

$$17.17 \text{ mg} \times \frac{126 \text{ min}}{289 \text{ min}} = 7.49 \text{ mg} = 0.00749 \text{ g}$$

Net tunnel effluent TSP mass:

$$115.17 \text{ mg} - 7.49 \text{ mg} = 107.68 \text{ mg} = 0.10768 \text{ g}$$

- Volume of air sampled by emission sampler:
  40 cfm x 126 min = 5040 ft^3 = 142.7 m^3
- Volume of air sampled by background sampler:
  40 cfm x 289 min = 11560 ft^3 = 327.3 m^3

Net TSP concentration:

$$\frac{107.68 \text{ mg}}{142.7 \text{ m}^3} = 0.755 \text{ mg/m}^3 = 0.000755 \text{ g/m}^3$$

- Tunnel effluent PM-10 Pu239 activity = 0.174 dpm
- Tunnel effluent >PM-10 Pu239 activity = 1.200 pCi/g

Tunnel effluent TSP Pu239 activity:

$$(1.200 \text{ pCi/g} \times 0.0426 \text{ g}) + 0.078 \text{ pCi} = 0.129 \text{ pCi}$$

- Tunnel inlet TSP Pu239 activity = 0.004 dpm

Tunnel inlet TSP Pu239 activity:

$$\frac{0.004 \text{ dpm/filter} \times 0.45 \text{ pCi/dpm}}{0.01717 \text{ g}} = 0.10 \text{ pCi/g}$$

$$0.10 \text{ pCi/g} \times 0.00749 \text{ g} = 0.000749 \text{ pCi}$$

Net TSP Pu239 activity:

$$0.129 \text{ pCi} - 0.000749 \text{ pCi} = 0.128 \text{ pCi}$$

$$\frac{0.128 \text{ pCi}}{0.10768 \text{ g}} = 1.189 \text{ pCi/g}$$

Pu239 concentration attributed to TSP eroded from soil:

$$1.189 \text{ pCi/g} \times 0.000755 \text{ g/m}^3 = 0.00090 \text{ pCi/m}^3$$